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QUADRUPLEX TELEGRAPHY.

We are not aware that a quadruplex circuit exists in England at present, although we are assured that since 1874 quadruplex telegraphy has been an established fact in America, and that its employment there has been eminently successful. Statistics are nevertheless wanting to establish its practical value; and, notwithstanding the valuable communication by Mr. G. B. Prescott, read before the Society of Telegraph Engineers at their last meeting, we seem to be still as much in the dark as ever as to the real advantages of quadruplex telegraphy. Without entering at all minutely into the system, it is sufficient to state that the difficulties inherent to the adoption of quadruplex telegraphy are greater than at first sight would be imagined. As a scientific problem, its success cannot be questioned. From the days when Gintl demonstrated the possibility of sending two communications in opposite directions simultaneously on the same wire, and Stark and Bosscha showed that the same thing might be done in the same direction on the same wire, quadruplex telegraphy, or, for the matter of that, theoretically, any multiple telegraphy, may be said to have been established. But for twenty years this appears to have remained a barren scientific fact; and it was not until the impulse given to further investigation in the field of duplex telegraphy by the successful labours of Stearns drew forth again the quadruplex question, that its practical introduction was seriously thought of. To America, unquestionably, belongs the credit of having revived the question, and, so far as we can judge, of having solved it with at least some degree of success. It is well to recognise and admit this fact, for in these days of fierce competition the rival claims set up by different countries for the introduction of anything that is new would undoubtedly soon extend to quadruplex telegraphy as well.

Quadruplex telegraphy being admitted as a scientific fact, there arises the question of to what extent is it likewise a practical success—in other words, what saving in money is actually effected by its introduction, for to this narrow limit all practical successes must eventually reduce themselves. On this point, as we have stated at the outset, statistics are unfortunately wanting; and, consequently, we are unable to form any opinion on the subject. It may, however, be well to remark, what was pointed out by Mr. Kempe the other evening, that the *primâ facie* case is not all upon one side. Quadruplex telegraphy, judging from the extremely elaborate and intricate diagrams which illustrated Mr. Prescott's paper, means very nice adjustment and consequent liability to derangement. If this is to be kept in order, intelligent and well-trained—which means at the same time comparatively highly paid—labour must be employed. We cannot say how far this applies to the United States. It is often urged that the technical training of the staff in the details of their apparatus is so well looked after there that little trouble is experienced with that comparatively fruitful source of trouble in every other country—adjustment.

Then, again, the reduced carrying power of the wire is a factor which ought not to be lost sight of. Rival inventors of duplex systems are often heard to urge that by employing their particular system the working becomes an easier matter than when the line is worked singly. We shall not be surprised to hear the same assertion made about the quadruplex system, although on the face of it there appears to be nothing to support the assertion, but, on the contrary, every reason against it, even so far as duplex telegraphy is concerned. Furthermore, working a quadruplex system—that is, four circuits upon one wire—to meet the requirements of busy centres of commerce, looks very much like entrusting too many of the eggs to one basket, and in the event of interruptions could not fail to be attended with the most serious inconvenience.

Mr. Preece very wisely, we think, in the discussion which followed the reading of Mr. Prescott's paper, refrained from saying a single word either way until he had had an opportunity of examining personally for himself and forming on the spot an opinion as to the value of the quadruplex system. Mr. Preece and his fellow-commissioner, Mr. Fischer, leave for America to-day, and not the least interesting fact that they will have to tell on their return will be what they find to be the true value of quadruplex telegraphy.

ON A NEW SYSTEM OF DUPLEX TELEGRAPHY.

By J. J. FAHIE, Assoc. Soc. Tel. Engineers.

This system is based upon two very simple facts, as follows:—

1st. When, in an arrangement such as that shown in fig. 1, the resistances A, B, E, and R are proportional, that is when

$$\frac{A}{B} = \frac{E}{R}$$

earth may be applied at the point P without affecting the deflection of the galvanometer needle G.

2nd. Although leaving the galvanometer undisturbed, the application of earth at the point P considerably reduces the strength of the current set up in R by the electromotive force E.

Fig. 2 shows the connections of the apparatus for use on land-lines. E E′ are voltaic batteries of (say) equal internal resistance and electromotive force, which, as will be seen, are connected so as to aid one another. They should have as little internal resistance as possible, for reasons which will be presently explained. R R′ are (say) Siemens' polarised relays. They are so joined up that the current in flowing through them shall keep the tongues against the insulated stops, the tongues themselves being adjusted to rest against the contact stops when no current is passing. In the circuit of each relay there is a fairly sensitive galvanoscope —not shown in the figure. AB A′B′ are rheostats of any pattern, but by preference such as will be hereafter described. K K′ are ordinary Morse keys, and L is the line. The local circuits differ in no way from those for ordinary single working, and, for the sake of clearness, are omitted from the figure.

Having connected the apparatus as shown in fig. 2, it only remains (to complete the adjustment) to determine the proper values for the shunts A B and A′ B′, and, this done, to find a point in each at which making and breaking contact with earth by means of the keys shall have no effect on their corresponding galvanoscopes—that is to say, R must not be affected by working K, nor R′ by K′. When this is so—

$$\frac{A}{B} = \frac{E}{L+X+E'} \text{ and } \frac{A'}{B'} = \frac{E'}{L+Y+E}$$

X being the combined resistance of the "down" station's relay and shunt, and Y that of the "up" station's.

Since the good working of the system depends on these proportions being always maintained, the internal resistance of the batteries should be small, in order that the total resistance in circuit may remain practically the same in all positions of the keys. For example, every time K is depressed the resistance of the apparatus is reduced by an amount which is a little less than E; and if this amount were considerable, the balance at the "down" station would be for the moment disturbed—the ratio $\frac{A'}{B} = \frac{E'}{L+Y+E}$ being no longer correct. Similarly, if E′ be large, depressing K′ will disturb the balance at the "up" station. The internal resistance, therefore, must be so small as to form but an inconsiderable portion of the total resistance.

Let us for the present suppose the proper values for the shunts to have been obtained, and that the apparatus is adjusted. Its action may then be explained as follows: For the sake of illustration, let E = E′ = 40 cells = 100 ohms. R = R′ = 600, A = A′ = 39, B = B′ = 1461, and L = 3050. When both keys are at rest a current circulates in the system, the strength of which is the added effects of E and E′, viz., $\frac{1+1}{4107}$, 4107 being the sum of all the resistances in circuit, and 1 + 1 the sum of the electromotive forces. Of this but $\frac{1}{4100}$ths, or 57 cells, goes through the relays, and keeps them well open. Let K be depressed to make a signal: calculation and observation alike show that the current in R is not affected thereby; E′ still sends a current to the line of practically the same strength as before; the very slight increase which we need not stop to appreciate being due to the fact that the total resistance in circuit is now somewhat less than before the depression of K. But the greater part of the current from E goes to earth *viâ* A and K and R B and K, and only the equivalent of 8·3 cells goes out to the line, or (say) $\frac{1}{4\cdot8}$ of the original strength, 40 cells. The current in the line is therefore 8·3 + 40 = 48·3 cells, and since but $\frac{1}{2100}$ths of this traverses R′, 34·5 cells instead of 57 cells represents the current by which the relay is now actuated, and this, by reason of the adjustment, is insufficient to keep the tongue from falling over to the contact stop. A signal, therefore, begins to be recorded, and its strength is the difference between 57 and 34·5 cells, or 22·5 cells. In all duplex telegraphs the effective current, or that by which the relays are actuated, is only about $\frac{1}{4}$ of the full battery. Here, as we see, it is $\frac{1}{3\cdot5}$. When K is raised after making the signal, the current from E again entirely flows out to line, and throws the tongue against the insulated stop, thus terminating the signal.

A like effect is produced by working K′, R′ is unaffected, while the current in R is reduced by 22·5 cells, and permits the tongue to fall over to the contact stop and close the local circuit. When both keys are depressed at the same time, the relays are worked by nearly the same difference of currents (in reality it is a very little less), while only a current equal to 16·6 cells remains in the line. According then to the positions of the keys the line is traversed by currents of the following strengths—80 cells when both levers at rest, 48·3 cells when one up and the other down, and 16·6 cells when both down.

We may now return to the question of the proper values for A B and A′ B′, for I think we can now understand why there must be some particular value for the shunt in its relation to the relay circuit and the line which will give a maximum effect. Thus, if it be too large, the current in the relay will be great, but the fall in the line on depressing the key will be small, and the difference between the full and reduced current in the distant relay may not be sufficient for rough working. If it be too small, the fall in the line will be great, but as the total current in the relay will be small, the difference of currents in the two positions of the key may still be insufficient. We must, therefore, give the shunts values which shall be large as compared to the relay circuit, and small as compared to the line, and we may proceed to determine them as follows: One station, say the "up," ascertains the resistance of the line and the distant galvanoscope, relay, and battery (W), and and that of his own galvanascope and relay (R), and pegs out in the shunt a resistance equal to

$$A + B = \sqrt{RW}$$

The "down" station then finds the resistance of

the line and "up" station's galvanoscope, relay, and battery (Z), and that of his own relay circuit (R), and makes—

$$A' + B' = \sqrt{R' Z}$$

Now, knowing that $A+B = \sqrt{RW}$, and knowing also the ratio that must subsist between them, namely—

$$\frac{A}{B} = \frac{E}{L+X+E'}$$

we get

$$B = \frac{L+X+E}{L+X+E'-E}\sqrt{R W}$$

and of course $A = \sqrt{RW} - B$.

A' and B' are found in a similar manner.

These values, or ones sufficiently approximate, can be obtained with any ordinary rheostat, and therefore any telegraph station provided with such an instrument, over and above the usual signalling apparatus, is able to work this system of duplex; but in practice I would recommend rheostats of somewhat novel construction on account of the greater accuracy and facility of adjustment which they afford. The coils might be arranged in rows, as follows :—

etc.	1000	400	300	200	100	40	30	20	10	4	3
	2	1	½	½	½	½	½	½	½	1	2
	3	4	10	20	30	40	100	200	300	400	1000 etc.

All the coils should be provided with pegs so as to be able to bring them in or out of circuit at pleasure, and the half unit coils should in addition have holes in the centre to receive a travelling peg; or a better arrangement still, the coils might be disposed in a circle with a handle, instead of a travelling peg, revolving on a pivot in the centre of the box, and making contact with the coils round the circumference. If designed specially as a duplex shunt the coils may be fewer, for the 200, 300, 400, and 1000, etc., coils on the A side will be unnecessary.

With such a rheostat the adjustments required to compensate for small changes in the resistances of the batteries and the line are easily and expeditiously effected, since we have only to slide the travelling peg or handle that is attached to the key along the half unit coils, watching at the same time until our galvanoscope ceases to be affected by depressing our key.

Of course if the changes be very considerable it will be advisable to find new values altogether for the shunts.

On the 5th of June 1874, the author being then in charge of Gwadur Telegraph Station, Baluchistan, this system was tried for the first time, and with perfect success, over a loop of 360 miles of land-line.

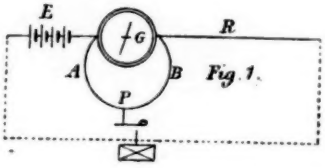


Fig. 1.

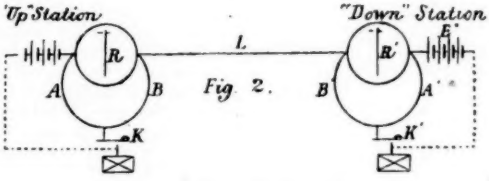


Fig. 2.

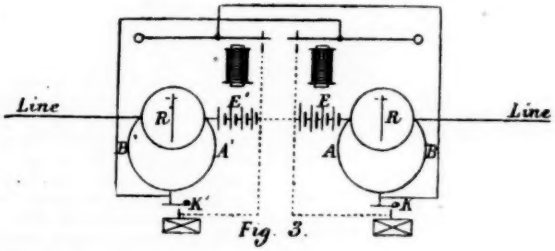


Fig. 3.

Since then it has frequently been at work on the Persian lines between Shiraz and Teheran, a distance of nearly 600 miles of magnificently insulated wire. In our experiments on these lines the batteries at each end consist of 40 minotti cells of low resistance; the recording instruments are ordinary land-line Morses by Siemens, with Wheatstone bridges, post-office pattern, as shunts. The speed at which we generally work is about 20 words a minute, but on occasions, during the great

heat of mid-day, as much as 26 words have been easily accomplished, and at other times 30 words.

The system has also been tried in England by the Messrs. Siemens, who have kindly favoured the author with the following opinion—

"We have made a series of experiments to compare the method of duplex telegraphy, suggested by Mr. Fahie, with other methods, and we are glad to say that, as far as our experiments show, we have found that results obtained by Mr. Fahie's method are equal to those of the best systems of duplex telegraphy which have come under our notice. We therefore believe the application of Mr. Fahie's system to duplex telegraphy to be of considerable usefulness.

"London, May 24, 1876."

The system can be worked through translation. Fig. 3 shows the connections at the intermediate stations.

I may now point out briefly some important advantages which this system possesses over existing ones, so far as I am acquainted with them.

1st. As the batteries here take the place of the artificial lines which form so vital a part of Stearns' methods, two rheostats are at once dispensed with.

2nd. At present when the line exceeds 100 miles, especially in dry weather, static discharge affects the signals, and the evil is counteracted by means of a complicated combination of condensers and electro-magnet coils. How favourably my system compares in this respect. It has been worked without a condenser of any sort, through not 100, but nearly 600 miles of land-line, which, for insulation and induction, is hardly inferior to any in the world. Its freedom from static discharge is owing to the fact that the line is never empty. When both keys are at rest, and when both depressed, one half the line is positively charged, and one half negatively—the amounts of course being much less in the latter case than in the former—when either lever is held down there is a preponderance of charge from the distant battery; but in every case the tendency to a discharge of the one sort is neutralised by the rushing in of the opposite current when the lever is again raised.

3rd. Since the currents from both ends combine and aid one another only half the battery power necessary in all other methods is here required at each end.

4th. No special sort of key or "transmitter" is required, and since with batteries of 2 or 3 ohms. per cell (and the less the better) the resistance of the circuit is practically the same in both positions of the lever the necessity for a compensating resistance does not exist, and thus another saving is effected.

In short, with the single exception of a rheostat, which most telegraph stations possess, no extra or special apparatus whatever is required. The saving, therefore, in money alone, effected by my system of duplex is something very considerable.

For cable and underground work the relays should be connected up in the opposite way to that shown in fig. 2, the tongues being adjusted as in ordinary single working, and the earth should be transferred from the front to the back stops of the keys, so that when at rest but a small portion of the total current enters the line. It *might* also be necessary (although I do not think so), on account of the great induction, to use shunts of considerable resistance, and thus work with a small fall, say 20 per cent., so that the static charges in the line may be as little disturbed as possible; but of this I cannot speak with any experience, never having had an opportunity of trying the system on a submarine line.

PHELPS'S ELECTRO-MOTOR PRINTING TELEGRAPH.*

(*Continued from page* 78.)

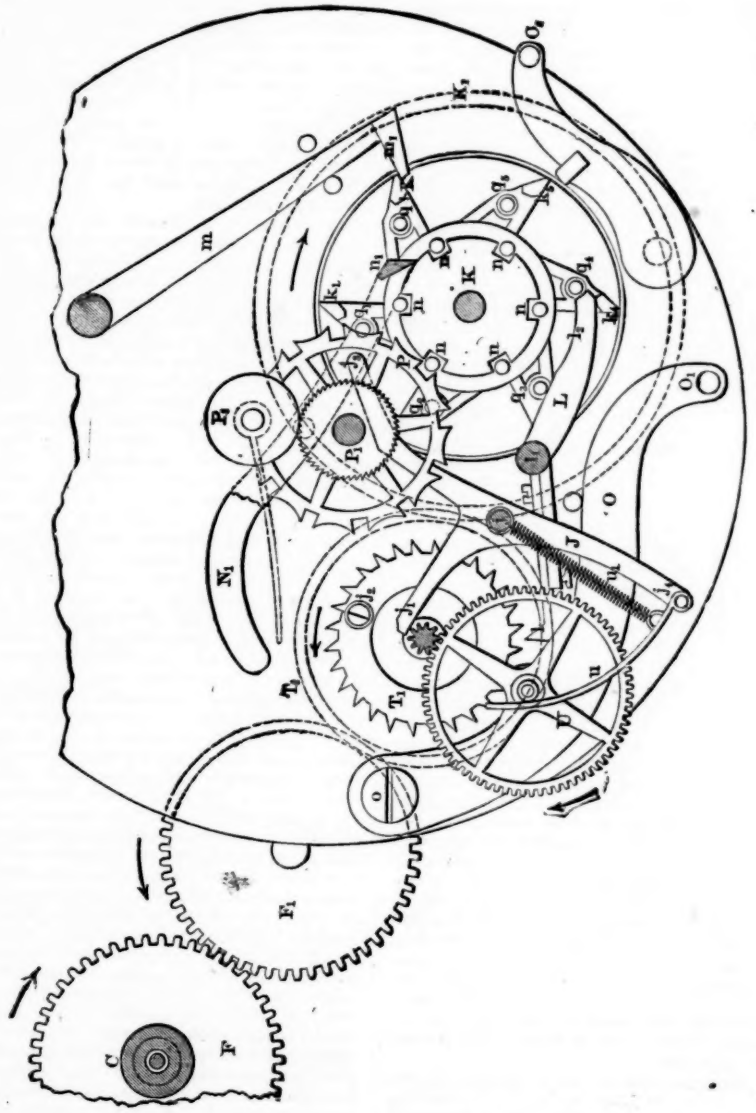
THE printing mechanism is represented in the plan view, fig. 7, while the outline drawing, fig. 8 (which is of full size), shows more clearly the arrangement and mutual action of the different parts. These are compactly arranged upon a horizontal circular plate, which is supported by a bracket upon the hollow column A at the right of the transmitting machinery. The type-wheel T is rigidly fixed upon the same axis with and directly above a wheel, T_1, of the same diameter, which is provided with twenty-eight sharp ratchet-shaped teeth, as shown in the figure. The wheels T and T_1 are upon a sleeve, and are attached by means of a friction plate to the axis of a toothed wheel, T_2 (shown in dotted lines in fig. 8 and also in the perspective view, fig. 1), which receives its motion from the wheel F upon the shaft C, through the intervention of an idle wheel F_1. As the wheels F and T_2 have each the same number of teeth, they must necessarily revolve synchronously. The type-wheel T is inked by means of the ink roller *t* (fig. 7), which is mounted upon a horizontal swinging arm t_1, and is constantly pressed against the type-wheel as it revolves, by the action of a spring t_2. In fig. 7 the contiguous portion of the type-wheel T and the ink roller *t* are represented as being broken away, in order to exhibit some of the parts lying beneath.

The star-shaped printing wheel K is perhaps the most important part of the entire printing mechanism. Under control of the electro-magnet M it performs the fourfold office of arresting the type-wheel at the proper point when a letter is to be printed; of forcing the platen and the paper into contact with the type thus presented, and instantly withdrawing it; of moving the paper forward the proper distance after the letter has been thus printed; and, finally, of releasing the type-wheel after the printing has been effected. The printing wheel is carried by friction upon the vertical axis of a toothed wheel, K_1, which receives its motion directly from the wheel T_2 upon the type-wheel axis, as shown in figures 1 and 8. There are 58 teeth in the wheel T_2, and 98 in the wheel K_1, consequently the former makes a little more than one and a half revolutions to each one of the latter.

The electro-magnet M is actuated by a local battery connected with the receiving relay, as before explained. To its armature is fixed the lever *m*, the latter being armed with a detent m_1, which takes hold of one of the points, *k*, of the printing wheel whenever no current is passing through the magnet. The detent m_1 is kept in position by the

* From Prescott's "Electricity and the Electric Telegraph." London: Spon & Co., Charing Cross.

FIG. 8.



tension of a spiral spring attached to the adjusting spindle m_2. The printing wheel K, being connected with the wheel k_5 by a frictional coupling, would revolve with the latter in the direction of the arrow, were it not held in check by the detent m_1.

The printing wheel K has six equidistant angular studs or pallets, k k_1 k_2, &c., projecting from its circumference, which serve as stops upon which the detent m_1 successively acts. Two concentric rows of vertical pins are inserted in the upper surface of the printing wheel. There are six of these pins in each row. The outer row of pins, q q_1 q_2 q_3 q_4 q_5, act upon a stop lever, which arrests the type-wheel, while the inner row, n n n, act upon the platen at the proper moment for giving the impression, and also upon the mechanism for moving the paper.

The operation of printing a letter is as follows: When the detent m_1 is momentarily lifted by the action of the electro-magnet M upon its armature, the pallet k is released, and the printing wheel K is carried forward one-sixth of an entire revolution, by reason of its frictional connection with the wheel K_1 beneath it. This movement of the printing wheel successively produces the following results: An angular projecting stud on the end of type-wheel stop lever L is caused to pass between the pallet k_4 and the pin q_4. As this lever turns upon a fulcrum at l_1, the detent l at its opposite extremity is instantly inserted between two teeth of the wheel T_1, and thus the revolution of the type-wheel T (which is carried by friction from wheel T) is suddenly arrested at that point. The details of this portion of the mechanism will be best understood by reference to fig. 9, which represents the parts enlarged to twice the actual dimensions. When the pin q_4 moves in the direction of the arrow, it bears against the inclined surface l_3 of the stop, and forces the lever L into a position by which the type-wheel is locked. The lever is retained in this position by the pin as it glides along the curved surface l_2, thus holding the type-wheel in check until the inclined face of the succeeding pallet k_5, coming in contact with the correspondingly inclined surface l_4 upon the lever L, returns the latter to its normal position, in readiness for the next repetition of the movement. Thus upon the release of the printing wheel K by the detent m_1 the type-wheel is instantly arrested, held in check while the printing wheel makes one-sixth of a revolution, and then released, the relative rate of motion of the type-wheel and printing wheel, as determined by the gearing, being such that the type-wheel is arrested for a length of time equal to precisely one-fourth that occupied in making a complete revolution, or, in other words, for one-sixteenth of a second. Its movements are therefore synchronous with those of the collar B of the transmitting apparatus, both in respect to its periods of motion and of rest.

During the time in which the type-wheel is thus held in check by the stop lever L the following movements take place, viz.: the inclined surface of the pallet n_1 on the end of the lever N_1 (figs. 7 and 8), which lies in the path of one of the pins n n upon the wheel K, is struck by the pin, and thus the platen N on the opposite side of the lever is caused to press the paper strip p p momentarily against the opposite type upon the type-wheel, from which it is again withdrawn by the action of the spring n_2 as soon as the pin n is free from the pallet n_1. The device for moving the paper forward is next brought into action. This is a modification of a mechanical movement known as the Geneva stop, the convex tooth being omitted. One of the rows of pins n n, &c. (see fig. 8), enters into one of the twelve notches of the periphery of the wheel P, and carries it forward one-twelfth of a revolution. Upon the axis of the wheel P is a roller, P_1, with a fine milled edge, against which presses a jockey roller P_2, mounted upon a spring. The paper strip p p is fed from a continuous roll, and passes through suitable guides in the frame Q between the rollers P_1 and P_2, by the movement of which it is carried forward the proper distance after the impression of each letter has been made.

It now remains to describe the automatic unison mechanism, which is one of the most interesting of the minor accessories of the Phelps apparatus. In all type printing systems it is, of course, necessary that the transmitting mechanism of one instrument and the type-wheel of the other should be in exact correspondence, and to effect this some means must be employed to ensure their starting together. In the Hughes and combination instruments this is accomplished by a simple stop lever, which takes hold of a stud upon the type-wheel whenever it is thrown into the path of the latter by the receiving operator. The first movement of the printing mechanism releases the type-wheel, which starts from the dash or space. It is therefore only requisite that the transmitting operator should release the type-wheel by first touching the dash key, and the other letters of the alphabet will necessarily fall into their proper relation. In Mr. Phelps' instrument an improvement is added by which the type-wheel is automatically arrested at the dash or zero point whenever it is permitted to make a few revolutions without printing. Upon the upper surface of the wheel T_1 (fig. 8), directly under the type-wheel, is a pin, j_3, which is filed to a flat surface on the side towards which the wheel itself revolves, as indicated by the arrow. J is a three-armed stop lever, turning upon a fulcrum j. U is a toothed wheel, mounted so as to revolve freely upon a pin fixed in the horizontal lever O, by moving which it may be thrown in or out of gear with a corresponding pinion on the type-wheel axis at the pleasure of the operator. Ordinarily, it is kept in gear with the pinion, and receives therefrom a slow rotary motion in the direction indicated by the arrow. A curved arm u, pivoted to the arm j_4 of the stop lever J, is constantly pressed against the revolving axis of the wheel U by the tension of the spiral spring U_1. The friction between the axis of the wheel U and the curved arm u has the effect of slowly but continually swinging the top lever J around towards the left whenever the type-wheel is in motion. If the printing wheel K meantime continues stationary, in the course of four or five revolutions of the type-wheel the lever J will be swung around into such a position that a stop which projects downwards from the end of the arm J^1 of the stop lever will be thrown into the path of the stop j_3 upon the wheel T_1, which latter will come in contact with it at its next revolution. The type-wheel will thus be arrested with its dash or blank space opposite the platen, in which position it

will remain until the printing mechanism is again operated. The instant, however, that the printing wheel K is released by the action of the electro-magnet, the stop lever J is thrown back into the position shown in fig. 8, because its third arm j now lies directly in the path of the pin q_2, upon the printing wheel. So long as one or more letters are printed at every revolution of the type-wheel, a continual succession of pins will strike against the arm j_3 and prevent the stop lever J from being swung around far enough to arrest the type-wheel, unless the operation of printing be suspended during several successive revolutions of the type-wheel axis, when the type-wheel will be automatically arrested, as before explained.

The electro-motor and its governor are mounted upon the base of the instrument at the left and to the rear of the hollow column A, which contains the transmitting mechanism. The motor consists of eight electro-magnets arranged in a circle, within which a revolving shaft carries a circular row of soft iron armatures, five in number. The commutator is so connected that the electro-magnets act successively as the armatures come within their influence, and cease to act just as the latter arrive at a point opposite to the poles of the magnets. By this means a constant attraction is exerted upon the armature, which causes the shaft to revolve with great rapidity. The motor is provided with a centrifugal governor, which acts to reduce the quantity of electricity flowing through the actuating magnets whenever the speed becomes too great, by which means its motion is rendered perfectly uniform.

Fig. 10 is a horizontal transverse section of the motor, showing the arrangements of the electro-magnets and armatures, and construction of the commutator, and fig. 11 is a vertical transverse section of the same. The figures are half the size of the actual parts.

(*To be continued.*)

FIG. 7.

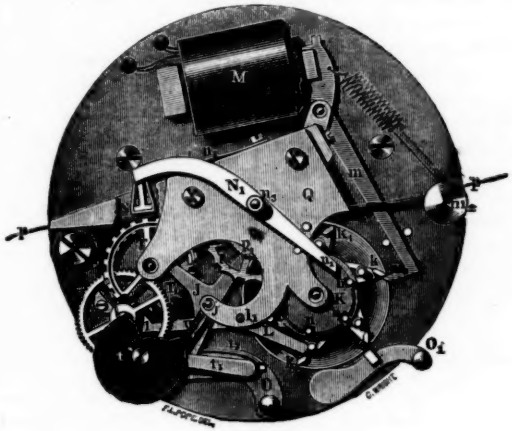
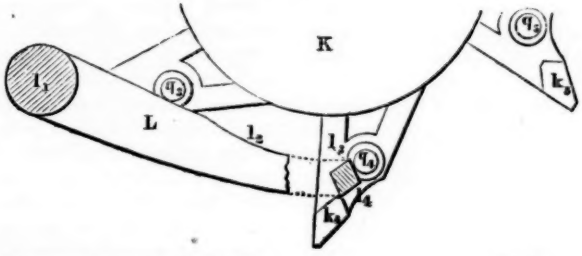


FIG. 9.



Notes.

THE last mail from the Cape of Good Hope has brought to England the news of the death of Mr. John Duncan Den, lately General Manager of Telegraphs for that colony. Mr. Den was, we believe, only thirty-five years of age. The following is from a notice which appeared in the Cape Town *Standard and Mail* of the 18th ult.: "The name of Mr. Den has been intimately associated with the introduction and extension of the electric telegraph in South Africa. As the right-hand man of Mr. Wollaston, the local representative of the Telegraph Company, the first line between Cape Town and Graham's Town was laid down under his personal superintendence; and, since then, he has been actively employed in the endeavour to perfect the system

amongst us. When the Government purchased the then existing lines, Mr. Den was appointed head of the department, and the appointment was regarded as the best step which could have been taken to secure a successful result. The public voice will tell how wise was the selection which was made. The colony has sustained a loss by Mr. Den's death which will long be felt. Up to Monday last Mr. Den was at his post, but in the evening of that day he complained of illness. A sharp attack of fever followed; and although everything which skill could suggest and loving hands perform was done, the struggle ended yesterday morning, and the busy worker went to rest. To the relatives of the deceased gentleman, and especially to his bereaved widow, we can but offer the expression of our most sincere sympathy. Mr. Den is no more. He has been called away before he had reached his prime, but he lived long enough to secure a place in the affections of his fellow-citizens and the colonists generally, which will long be kept sacred to his memory.

WE learn that Don Carlos Paz Soldan has been appointed Director-General of Telegraphs in Peru.

THE long contest which was waged between the Direct United States Cable Company and the Globe Trust Telegraph Company, and to which reference has oftener than once been made in our City notes, has at length been brought to a close. The Direct Company has practically been vanquished, and it is difficult to see what its future will be. Mr. Pender, the moving spirit of the opposition, has carried every point for which he fought, and is practically the "telegraph king" of the City. He not unnaturally suggests to our minds that of another "king," who, when railway speculation was all the rage, occupied much the same position towards them as Mr. Pender does towards the telegraphs. Let us hope, however, that the simile will not be continued further.

THOSE who were fortunate enough to be in the neighbourhood of Telegraph Street about two o'clock on the afternoon of Wednesday last would have witnessed one of the most interesting phenomena in connection with the electrical discharge which have occurred of recent years. The underground lines of telegraph pass along Telegraph Street from the old central telegraph station into Moorgate Street, and at the corner there is one of the usual flush-boxes with stone covers. As is well known, the pipes containing underground wires are at all times more or less full of gas, which manages to make its way into them. During the thunderstorm which passed over London on Wednesday, an electrical discharge, due no doubt to the induction generated by the lightning, took place in this line of pipes, and, igniting the gas, blew the stone covers off the flush-boxes mentioned for some little distance into the air. A jet of flame was also, it was stated, momentarily seen to issue from the pipes, but whether this really was the case or whether the unscientific imagination was again at work here it is difficult to discover.

THE remarks made by Mr. John Muirhead, jun., at the meeting of the Society of Telegraph Engineers, exhibit the unfortunate difficulty which stands in the way of the ventilation of any subject of practical value which is brought forward. Mr. Muirhead's remarks were, every one will admit, couched in the most excellent spirit, and it can only be a subject of extreme regret that impending legal difficulties should be allowed to bar the free expression of opinion so conducive to progress. The various duplex systems employed upon submarine cables make use, one and all, of the condenser in some shape or other, and this unfortunately forms the *bête noire* referred to.

THE legal difficulties seem to be almost as great a bugbear as the question of priority in inventions. No sooner is an invention, which every one has been inclined to sneer at, established as a success than assailants come into the field and claim for themselves the fostering of the now healthy fledgling. The rise of telegraphy has long since been given over as a hopeless question, and the duplex seems to be almost as fruitful a source of trouble as the origin of the science itself. Were we to believe half of what is told us, the fact would be assured that duplex telegraphy existed even before telegraphy itself, and we may be quite prepared to hear at any moment of some ardent student in the past discovering, before Galvani experimented with his frogs, or even Thales taught of the amber, simultaneous transmission on the same wire in opposite directions. While on the historical subject of duplex telegraphy we may mention that our attention has just been drawn to a little work entitled "Hughes' Reading Lessons," which appeared in 1856, in which a very interesting though short descriptive article upon the system appears. It is from the pen of Mr. C. V. Walker, who, even at that early period, was to the front in everything relating to telegraphy.

THERE can be no question now that the telephone is to be regarded as a practical success. There are so many observers and so many unbiassed witnesses whose accounts have reached us that no further room is left for any uncertainty on the point. A

very interesting article from the New York correspondent of the *Standard* appeared in that paper on Thursday. He details very accurately the two different methods—that of Dr. Bell and that of Mr. Elisha Gray—which are struggling for supremacy in the States. Dr. Bell's will appear to be the more perfect of the two, although Mr. Gray has succeeded in transmitting the sounds over far greater distances. The longest journey which they have had to travel has been from Chicago to Detroit, a distance of 284 miles. A c ncert was to be held on the 2nd inst. at the Steinway Hall in New York, to which the New Yorkers were to be admitted at a dollar a head in order to listen to a performer playing in Philadelphia, some 90 miles away. It is somewhat strange that so little has been heard of this marvellous invention in England, for, apart from the interesting exhibition made by Messrs. Wray at the conversazione of the Society of Telegraph Engineers, nothing whatever appears to have been done in this country.

AT the next meeting of the Society of Telegraph Engineers the paper to be read is on "Batteries," by Mr. Martin Roberts, F.C.S.

OUR attention has been drawn to a method of synchronising clocks recently brought out by Messrs. Barraud and Lund, of Cornhill. In the means hitherto adopted for synchronising any number of clocks difficulties of various kinds have arisen which have hitherto been practically insurmountable. The system hitherto in vogue has simply been to control the clocks by means of an electric current either acting on the pendulum or on some other portion of the works. The system patented by Messrs. Barraud and Lund discards all attempts to control the clocks, and provides instead for their being automatically set to time every hour or at such stated intervals of time as may be arranged. The mechanical parts are exceedingly simple, although space prevents our going into them at present. To those who take an interest in the subject we recommend a personal inspection.

TRAFFIC RECEIPTS.

1877.	Anglo American Co.	Brazilian Sub. Co.	Cuba Sub. Co.	Direct Spanish Co.	Direct U. S. Co.	Grt. Northern Co.	West Coast America Co.	Western and Brazilian Co.
	£	£	£	£	£	francs.	£	£
January	37,780	11,469	2,311	983	13,530	316,565	*b*2,533	10,100
February ...	32,330		*2,300	784	15,520	320,000	*c*	11,026
March	18,880		*2,700	913	8,110	402,878	*d*3,128	

* Estimated. *b*, four weeks ending 13th January. *c*, four weeks ending 13th February. *d*, four weeks ending 10th March.

City Notes.

Old Broad Street, April 14, 1877.

THE fiercely waged war between the Globe and the Direct Company has at last come to an end, and Mr. Pender has triumphed. To his tender mercies are now intrusted the care and management of the young company, and under his watchful eye its affairs are to be brought into a condition which will bring at once the long-expected dividend. We have already said so much upon this subject, and we have already pointed out oftener than once what in our opinion the future will bring forth, that it is needless to add at present a single word more on the subject. We shall now be content to stand by for a time and wait. It occurred to us as we sat the other day in the meeting at the Cannon Street Hotel that the Direct Company, as a company, may now appropriately salute its new monarch as the gladiators of ancient Rome hailed the emperor—"*Te morituri salutant Cæsareno.*"

The Anglo Company have declared the handsome dividend for the quarter ending March 31st of ½ per cent. on the ordinary and 1 per cent. on the preferred stock! This compares somewhat unfavourably with the corresponding period of last year, when the holders of ordinary stock received 1¼ per cent., and of preferred 2½ per cent. But the wonder really is how they managed to pay any dividend at all, and it bespeaks, to say the least, good management on the part of those who are really at the helm of the ship. Talking of management, it would be interesting to know what Mr. Weaver really thinks of all the knocking about in the property under his stewardship. Does he approve of amalgamation? Rumour says he does not, and if rumour really does, as we believe in this instance it does, carry the truth with it, no more powerful argument can be brought forward against the ill-advised policy which has brought matters to their present pass. The Globe Company—whose shares, by the way, still continue to hover about the neighbourhood of £5—is now practically the Direct; and unless amalgamation or something akin to it takes place, we shall find a split in the camp before long, and then we may see the verification of the oft-quoted saying of certain people getting their own when other certain people do not agree.

The "working arrangement" has, no doubt, been come to, for the notice is out that, on and after the 1st of May, the old rate of three shillings per word to and from America will be reverted to, and monopoly will for a period reassume her ancient reign. Yet, notwithstanding this announcement, the shares of both companies are already on the

ebb. Anglos are at 56 and Directs are at 10¾. Speculators and stockjobbers will no doubt succeed in running their value up and down from time to time, but neither property is, in our opinion, intrinsically worth the prices quoted above, and did we hold, as happily we are not now fated to, a single share in either company, we would willingly part at once with it. The highest value which could ever have been assigned to a Direct share, even had a dividend been paid on it, was 12, and never again, we are inclined to think, will that limit be reached. Telegraph property, it is needless to repeat, is unusually risky, and so long as a company has but one cable that risk is intensified. To any of our readers who require advice, we say "Sell out."

During the time that the battle raged between the Globe and the Direct almost every other telegraphic question dwindled, in comparison, into insignificance. We now propose to return to those companies who are attempting to "hold on the noiseless tenor of their ways," and we shall, as occasion offers, analyse the market value and commercial doings of these, adding now and again a few additional words respecting any which may be more prominently before the public.

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

AT the meeting of this Society, held on Wednesday, 28th March, the President announced that a handsome portrait of Sir William Fothergill Cooke had been presented to the Society by Mr. Latimer Clark, and proposed that a hearty vote of thanks should be accorded to Mr. Clark for his gift. The vote having been unanimously carried, the President then intimated that Major Webber, after his connection with the Society as Honorary Treasurer since its foundation, had resigned his office, and that Mr. Sivewright, finding himself unable to continue the duties of Acting Secretary, had also tendered his resignation; Mr. William Langdon, however, had been appointed by the council as Mr. Sivewright's successor.

The adjourned discussion on Mr. Higgins' paper on "Type Printing Instruments" was then resumed by Mr. Langdon and the author, when a vote of thanks was accorded, on the motion of the President, to Mr. Higgins for his paper.

A paper on "Underground Telegraphs" was then read by the author, Mr. Willoughby Smith, a *resumé* of which is appended:—

UNDERGROUND TELEGRAPHS.

In the *Journal of the Telegraph*, dated September 1, 1876, under the heading of "An Interesting Statement," after recapitulating what had been done in England in 1852-3, appeared the following statement: "The most experienced telegraph engineers and electricians of all countries in which underground wires have been used, are united in the opinion that thus far at least their use has been attended with very unsatisfactory results, and that no method of construction yet devised has maintained underground wires in working order for any length of time."

Mr. Smith was of opinion that that statement, emanating, as he believed it to have done, from an American gentleman of high authority, ought not to pass unchallenged. True it was that the failure which followed the laying down of the system of underground wires in England during the above-mentioned years gave a blow to the prospects of subterranean lines, from which they have never yet recovered; but, on the other hand, when we take into consideration the manner in which the wires were then made and the system carried out, we can feel no surprise at their early failure, and our only wonder can be that they lasted so long as they did.

In 1853 four of the then largest telegraph companies were engaged in the manufacture of the wire, which they subsequently laid in the later part of the year between London and most of the large towns in England. In June of the same year part of the factory of one company which supplied most of the wires was destroyed by fire, which did not help matters, inasmuch as each company, in their anxiety to complete their respective lines, allowed a laxity of supervision which would not otherwise have existed. Coal-tar, naphtha, and other solvents of gutta-percha were applied between the coatings to effect adhesion, but which evidently exercised a deleterious action upon the gutta-percha.

In 1857 Mr. Smith introduced an adhesive mixture for this purpose, consisting of 60 per cent. of Stockholm tar, 20 per cent. of resin, and 20 per cent. of gutta-percha, at present known as Chatterton's compound, and this has been almost unexceptionally employed since that date, and with every success.

The conductor employed was a solid copper wire, weighing 63 lb. to the mile, and of very inferior conducting power; some lengths have since been found to possess only 18 per cent. of the conductivity of pure copper.

The system of testing employed was very rough. The wire was immersed in water at no specified temperature, one end left free, and the other connected to one terminal of a sand battery of 360 cells, and with what would now be considered a very dull vertical galvanometer; if the deflections so obtained were not high, the coil was considered good, and delivery soon followed. When subsequently faults were discovered, the pernicious system of pricking the wires was resorted to.

The manner of laying the wire was equally detrimental to its longevity. One company laid part of their wire without any protection whatever in the six-foot of a railway, and the remainder were laid in square *creosoted* wooden blocks, from six to ten feet in length, with a groove of sufficient size to contain them. Boards of the same material were then *nailed* on after the wire had been laid, and the trench in which the whole had been placed was then filled in. The nails penetrated the gutta-percha in many places, and so numerous were faults of this nature that nails had to be abandoned, and the troughs were bound with wire instead.

Another company laid their wires just as they received them from the manufactory, in a somewhat similar manner, after having passed them through a bath of *hot coal-tar*, and then allowed them to dry in the sun, suspended from bars of wood.

In 1861 Mr. Smith introduced a great improvement upon the tarring process, viz., that known as the "wet serving." He advocated the use of an external conducting serving in the form of tanned hemp, inasmuch as tar, being an insulator, possesses the property of temporarily concealing the presence of a fault which must ultimately develop itself. Another and still greater argument against the use of tar is the prejudicial effect exercised by it on the durability of any gutta-percha covered wire, especially when exposed to atmospheric influences. Since that date the use of tar in connection with submarine cables ceased, though it still continues to be employed in the case of subterranean lines, and it was with a view to induce its discontinuance in the latter also that Mr. Smith undertook the following experiments:—

Three separate samples of what was said to be pure Stockholm tar were procured from three different sources, and three lengths, 1,000 yards each, of core, containing 107 lb. of copper and 140 lb. of gutta-percha per nautical mile, were immersed, one length in each sample. In the coil marked No. 1, the tar was kept at a uniform temperature of 90° Fahr. while the coil was immersed in it. Daily tests of the resistance of the gutta-percha were taken, and the results carefully noted. The fall in its resistance

decreased daily. From June 8 to November 21 the resistance had fallen from 62 to 1·25 megohms per knot. The coil was then cleansed from the tar and immersed in water, which was kept at 90°. From November 27 until March 5 the resistance gradually *increased* from 1·257 to 26·96 megohms per knot, and then gradually began to fall, and on May 20 its resistance was 2·237 megohms per knot. For three years this core remained immersed in water at no regular temperature. The water was then kept at 75° Fahr. for twenty-four hours, and the resistance was then found to be *nil*. The coil was then divided into four equal lengths, and each length gave the same result, showing that the resistance was destroyed by no local fault, but was general throughout the entire length.

Coil marked No. 2. In this experiment the conditions were precisely the same as in the previous one, with the exception that the tar was not kept at an uniform temperature, but varied during the experiment, the minimum being 60° and the maximum 68° Fahr. During four years the resistance gradually decreased from 13·98 to 4·76 megohms per knot. After being cleansed from the tar, and immersed in water at a temperature of 75° degrees for twenty-four hours, the resistance increased to 11·43 megohms per knot. This coil was divided also into four equal lengths, and the result showed a depreciation throughout the coil.

Coil marked No. 3. This experiment was conducted precisely the same as with coil marked No. 1. From June 12 to November 21 the resistance gradually fell from 74·4 to 0·587 megohms per knot. It was then thoroughly cleansed from the tar and immersed in water. From November 27 to December 22 the resistance gradually increased to 3·55 megohms per knot, and then began to decrease, and at the end of one month its resistance was *nil*. The depreciation was uniform throughout the entire length. When one end of the conductor was connected to one terminal of an induction coil, and a wire from the other terminal to which was attached a piece of moist sponge was passed near the surface of the gutta-percha, it was instructive to see the current, in the form of a luminous brush, passing freely through the gutta-percha; and at distances varying from seven to nine inches the current broke through the gutta-percha with force, leaving a hole resembling a puncture made by a small blunt instrument. No such effects were produced on a length of the same core which had not been in tar, but kept at the same temperature in water, when subjected to precisely the same treatment. It will be seen that the action of the tar on the electrical qualities of the gutta-percha was more rapid on coil 3 than on coil 1. Although the tar used with coil 3 was said to be from Stockholm, it was much inferior in quality to the other two samples. It will also be seen that the higher the temperature the quicker the effect on the gutta-percha. Coal-tar has a much quicker effect than Stockholm-tar, and coal-tar naphtha very quickly destroys its insulating properties, and disintegrates the gutta-percha, causing it to "crumble like old putty."

At the close of the last session Mr. Smith brought forward a new form of joint of which he had great hopes, and from which he had already succeeded in getting very high insulation; but he had at that time only two months' experience of its mechanical and electrical properties. Since that time, however, it had been regularly submitted to severe tests, and he could now speak of it with more confidence. He had at first advocated the use of Chatterton's Compound in the formation of that joint; but however suited that compound may be for the purposes for which it is employed, he preferred at present to use a compound of gutta-percha and resin alone. Mr. Smith also exhibited several lengths of wire containing joints, and stated the insulation resistance of each length in megohms; also two test boxes—one to contain twenty and the other over a hundred joints.

Mr. Smith also proposed that the size of the wire at present in use should be increased comparatively, as the thin coating of gutta-percha causes the wire to be in danger of receiving mechanical injury when handled.

In conclusion, Mr. Willoughby Smith expressed his opinion that if proper care were taken in the testing of the wire and its subsequent mechanical protection, we possess no data which point to failure; on the contrary, as subterranean wires come more and more into favour, all the evidence which we can at the present gather points unmistakably to success in this direction.

An interesting paper was then read upon "The Underground Telegraphs in France" by Mr. John Aylmer, the Society's Local Honorary Secretary in that country. We are prevented from entering to any extent into the ingenious contrivances mentioned in this paper beyond the fact that in Paris the underground system is chiefly placed in an extensive network of sewers beneath the streets of that city; a cable is made the size depending upon the number of wires required, and laid in leaden piping supported along the walls of these sewers.

When the piping is completed a carrier, to which is attached a light cord, is sent through by pneumatic pressure. When the carrier arrives at the distant end of the section it is removed, and the cord which it has brought through used to pull in a wire, which in its turn pulls in the cable.

The discussion on these papers was taken up by Messrs. Schramm, Truman, and Treuenfeld, Mr. W. H. Preece, Sir Charles Bright, the President, and Mr. Willoughby Smith.

Mr. Schramm described the form of subterrannean line employed by the German government.

Mr. Truman asked why it was that if tar was so injurious to the durability, the compound mentioned by Mr. Smith, in which tar existed to the extent of 60 per cent., was not also injurious, and expressed his opinion that it was so, and that he thought the time was not far distant when cable-core would be formed by a copper strand covered by a single coating of gutta-percha, inasmuch as the difficulties which presented themselves in the early days of cable manufacture, and which necessitated the building up of the core, have long since been obviated.

Mr. W. H. Preece gave an entertaining history of tar in connection with gutta-percha covered wires, mentioning that the chief inducement offered by the use of tar, which ended in its subsequent employment, was the fact of its filling up any fissures in the gutta-percha with an insulating fluid.

Mr. Treuenfeld remarked that it would be interesting to know whether tar formed any known chemical reaction in the presence of gutta-percha.

Sir Charles Bright gave an interesting historical account of some of the lines mentioned in Mr. Willoughby Smith's paper which he himself laid down.

The President then stated that, with reference to the question raised by Mr. Treuenfeld, the actual chemical action which takes place when tar and gutta-percha are in contact are somewhat difficult to determine, since tar itself is not a simple chemical substance but a mixture of substances, all possessing more or less a solvent action on the percha, and also that no two samples of tar are chemically alike.

Mr. Willoughby Smith, having replied to his paper, a vote of thanks was unanimously accorded on the motion of the president to the authors for their valuable papers.

The meeting then adjourned.

WE understand that Mr. Sivewright is about to proceed to the Cape Colony to investigate the working of the telegraph system at that place. From his experience in the Home Postal Telegraph Service, Mr. Sivewright is eminently fitted for such a task.

PATENTS.

2941. J. W. BROWN.—"Electric telegraphs."—19th July, 1876.

3003. R. H. RIDOUT.—"Methods of constructing galvanometers."—25th July.

3012. T. A. EDISON.—"Acoustic Telegraphs."—26th July.

3016. H. PAGE.—"A new method of apparatus for transmitting written messages."—26th July.

3017. S. P. BIDDLE.—"Electric Telegraphs."—26th July.

3099. H. P. SCOTT.—"Improvements in telegraph wires and cables, and in the means of insulating the same when used for subterranean, submarine, or other lines."—3rd August. (A communication.)

3138. S. G. L. FOX.—"Means or apparatus for lighting and extinguishing gas lamps by electricity."—8th August.

3186. J. A. DESGOFFE.—"Improvements in sheet iron uprights for telegraph posts, chimneys, masts, and all metallic supports."—12th August.

3203. G. M. PHELPS.—"Printing telegraphs and an instrument or apparatus for such purpose."—14th August.

3264. A. M. CLARK.—"Dynamo-electric and magneto-electric machines."—19th August. (A communication.)

3315. J. H. JOHNSON.—"Improvements in the production of the electric light for signalling and other purposes, and in apparatus therefor."—23rd August. (A communication.)

3361. W. H. DAVIS and F. H. W. HIGGINS.—"Telegraphic signalling instruments for transmitting fire and other calls or alarms."—26th August.

3412. J. E. MASSEY.—"Ship's logs and the apparatus for holding same, registering on board by electricity."—30th August.

3462. E. G. BREWER.—"New and improved method of, and apparatus for, obtaining light by electricity."—2nd September. (A communication.)

3466. D. G. FITZGERALD.—"Electrical condensers or accumulators."—2nd September.

3533. W. C. JOHNSON and S. E. PHILLIPS.—"Improvements in the manufacture of submarine and other telegraph cables, and an apparatus connected therewith."—8th September.

3534. W. C. JOHNSON and S. C. PHILLIPS.—"Insulators for telegraph wires."—8th September.

3537. E. G. BREWER.—"A new or improved telegraphic instrument, chiefly applicable to the receiving of telegraph messages."—8th September.

3552. R. APPLEGARTH.—"Electric light."—11th September. (A communication.)

3670. C. A. FAURE.—"Improvements in thermo-electric generators and in electro-motors."—19th September.

3688. W. SMITH and R. R. HARPER.—"Improvements in the mode of arranging the connections of electro-magnetic signalling instruments."—20th September.

3710. S. J. V. DAY.—"Telegraphic instruments."—22nd September. (A communication.)

3782. J. L. PULVERMACHER.—"Apparatus or appliances connected with generating, conducting, measuring or testing, and applying electricity."—28th September.

4081. H. GARDNER.—"Apparatus connected with submarine telegraphy."—21st October. (A communication.)

4084. T. NORDENFELT.—"Electric railway signalling and the effects thereof."—28th October. (A communication.)

4153. J. COLE.—"Construction and arrangement of magnetic apparatus to be employed for curative and remedial purposes."—26th October.

4167. A. JAMIESON.—"Grapnels for submarine or submerged cables."—27th October.

4222. G. ZANNI.—"Improvements relating to the application of magneto-electricity, or magnetism, or natural electricity to swimming and other baths for curative and anæsthetic purposes."—1st November.

4269. G. SCHAUB.—"Improvements in electro-magnetic engines, and in means or apparatus for generating thermo-electricity for that purpose, parts of which improvements are also applicable to other purposes."—4th November.

4280. H. J. HADDON.—"Magneto-electric machines."—6th November. (A communication.)

4312. A. M. CLARK.—"An improved electric light buoy."—7th November. (A communication.)

4461. J. LOEFFLER and R. HIGGS.—"Electric telegraphs."—18th November.

4595. W. R. LAKE.—"Electro-magnetic engines."—28th November. (A communication.)

4597. E. H. C. MONCKTON.—"Improvements in generating and applying the electric current, and in producing motive power and in the apparatus therefor."—28th November.

4636. P. MORITZ.—"Improvements in electric night signal apparatus simultaneously illuminating the horizon and automatically registering the signals."—30th November.

4705. H. E. NEWTON.—"Improvements applicable to the manufacture of telegraphic and other conductors covered with caoutchouc or other insulating substance."—5th December. (A communication.)

4765. W. MORGAN BROWN.—"Improvements in electric telegraphy and telephonic apparatus."—9th December.

4805. R. WERDERMANN.—"Electric lighting apparatus."—12th December.

4876. SIR W. THOMSON.—"Mariner's compass and appliances for ascertaining and correcting its errors."—18th December.

4905. S. A. VARLEY.—"Improvements in apparatus for producing the electric light, parts of which invention are applicable to other purposes."—19th December.

CORRESPONDENCE.

WE have received a letter from Mr. S. Phillips, sen., with reference to his son's improved insulators.* Mr. Phillips states "that the idea is perfectly new and original." He further goes on to say that "it is well known that insulators may be, and are, in some extreme cases, improved by wiping or rubbing over with paraffine, but all such attentions are inconveniently expensive, and the very small advantage is very evanescent.

"A mile of wire with twenty insulators has now been subjected to three months of winter weather, and still tests as well as ever in rain. The Post Office authorities have them on trial in two of their worst situations, and the Eastern Telegraph Company have tried them on a very bad length of line at Penzance."

We propose to return again to this subject in an article on "Insulators."

* Vol V. *Telegraphic Journal*, page 79.